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Early Student Support for Process Studies of Surface Freshwater Dispersal

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LONG-TERM GOALS

To understand the processes affecting the fate of freshwater layers and their residence time, while focusing on the dispersal and mixing of freshwater through vertical and horizontal processes.

OBJECTIVES

The objective is to support, mentor and nurture a student through a Ph.D. in the MIT/WHOI Joint Program in Physical Oceanography. The student will have the opportunity to become involved in the ASIRI (Air-sea interaction regional initiative in the Northern Indian Ocean) DRI and base his Ph.D. on observations made in this program, once he begins to participate.

APPROACH

In the first 18-24 months of the Ph.D. program, the student typically has a full course load and carries out research in free time (typically, in January, when classes are not in session, and in the summer). In the second year, the student develops a thesis proposal. The grant currently funds a student, Sebastian Essink, who was a Guest Student at WHOI from November 2012-August 2013, and was admitted to the Joint Program this year to pursue a Ph.D. under the supervision of Amala Mahadevan. A student who was previously funded for one semester (Fall 2012) discontinued work under this project.

PRELIMINARY RESULTS

Sebastian has been working on modeling and analysis of stirring and Lagrangian dynamics in a 2-dimensional model. The renovating wave model is used to generate a randomly stirred flow field in a domain with periodic boundaries. A tracer field, with an initially uniform gradient in one direction is stirred. Lagrangian particles are introduced. These particles perform Brownian motion; hence a cloud of particles exhibits diffusion. The step size of the Brownian motion is controlled to change the Peclet number.

The particles respond actively to the stirred tracer field, which can be thought of as a resource. For example, they can reduce the step length of their Brownian motion when they are in a favorable environment. We find that by modifying merely the step size, i.e. the Peclet number, we generate differing rates of aggregation and patchiness. We use different measures to quantify patchiness and relate it to the particle Peclet number.

The work that Sebastian has done as a Guest Student, and his participation in WHOI's educational activities, earned him admission to the Ph.D. program, which he was very keen to join.

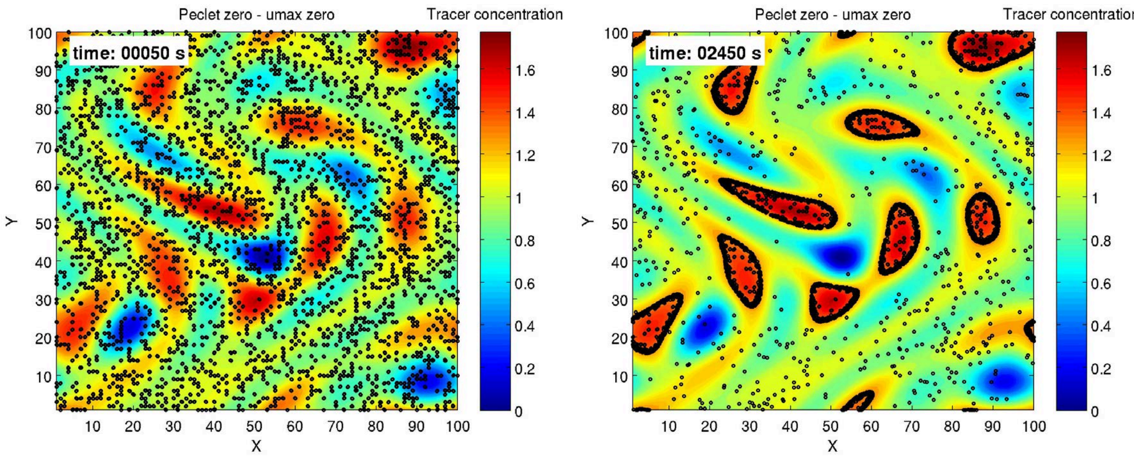

Figure 1 The tracer field (a resource) stirred by a random (phase) renovating wave model is shown in color. The black dots denote Lagrangian particles that modify their Brownian motion (step size of random jump) in response to the tracer, resulting in aggregation. (a) Early time, and (b) later time in the model, showing an example of the patchiness generated through this behavior.

OUTCOME / FUTURE WORK

This study has helped lay the foundation for Sebastian's understanding of two-dimensional stirring, mixing, numerical modeling using finite volume methods, Lagrangian modeling, and analysis. It will likely result in a manuscript o biophysical interactions in an evolving (stirred) medium.

Sebastian is interested in learning more about the measurements that will take place in ASIRI and in participating in the analysis and modeling effort. He will become involved in the analysis of the bioptical measurements from Leg 2 of the ASIRI cruise in December.